Highlights

This analysis responds to a request from the Subcommittee on National Economic Growth, Natural Resources, and Regulatory Affairs of the U.S. House of Representatives Committee on Government Reform[1] to examine the costs of power sector multi-emission reduction strategies (see Appendix A for the requesting letters). The Subcommittee asked the Energy Information Administration (EIA) to examine the impacts of imposing caps on power sector emissions of nitrogen oxides (NO_x), sulfur dioxide (SO_2), mercury (Hg), and carbon dioxide (CO_2), with and without a renewable portfolio standard (RPS). Specifically, the Subcommittee requested "that EIA analyze the cost implications—the likely impacts on both consumers and energy markets" of various multi-pollutant strategies. EIA's analysis examines the effects of each of the emission caps and the RPS, both alone and in various combinations.

The analysis was prepared using EIA's National Energy Modeling System (NEMS). The reference case incorporates the NO_x and SO_2 regulations established in the Clean Air Act Amendments of 1990 but does not include limitations on either Hg or CO_2 emissions. The key results—assuming a cap and trade system except where noted—are summarized below.[2]

Reducing Power Sector NO_x and SO_2 Emissions

- Reducing power sector NO_x and SO_2 emissions to 75 percent below their 1997 level is projected to lead to the installation of a large amount of pollution control equipment, with little change in fuel use for electricity generation.
- Power suppliers are projected to incur significant expenditures in order to comply with NO_x and SO_2 caps, but electricity prices are expected to be only slightly higher as a result—generally within 1 percent of the reference case level.

Reducing Power Sector Hg Emissions

- Reducing power sector Hg emissions to 90 percent below their 1997 level is also projected to lead to the installation of a large amount of pollution control equipment. A shift in fuel use from coal to natural gas (7 percent in 2020) is also projected, because some coal-fired plants would not be operated as intensively if their generating costs were higher.
- The cost and price impacts of reducing power sector Hg emissions are projected to be larger than those of reducing NO_x or SO_2 emissions, with national average electricity prices projected to be 3 to 4 percent above reference case levels, on average, between 2010 and 2020.
- Although research on the measurement and removal of power sector Hg emissions has been carried out in recent years, the factors that contribute to the emissions and the capabilities of the technologies available for reducing them are not fully understood. There is considerable uncertainty about the cost and performance of Hg removal technologies, because full-scale demonstrations have not been carried out. The actual costs and performance of the available technologies (and others yet to be tested) may turn out to be different from those assumed for this analysis. A sensitivity case is analyzed to examine the potential impacts of technological improvements, assuming substantial (but not infeasible, given ongoing research) performance improvements in Hg removal technology. The price impacts are similar to those for reducing NO_x and SO_2 emissions.
- When Hg emissions are assumed to be reduced by using a maximum achievable control technology (MACT) approach requiring 90 percent removal, rather than an emissions cap and trade system capping Hg emissions at 90 percent below the 1997 level, the projected Hg emissions total 8 tons annually, 3 tons above the total in the cap and trade case. Electricity prices, while higher than in the reference case, are somewhat lower than in the cap and trade case.

[1] In the 107th Congress this Subcommittee has been renamed the Subcommittee on Energy Policy, Natural Resources and Regulatory Affairs.

[2] All the results presented in this report are based on the assumption that electric power generators must meet the specified emissions caps fully, without trading with other domestic sectors or internationally and without credits for offsets, such as reductions in other greenhouse gas emissions or changes in forestry practices. Allowing trading with other sectors and offset credits could produce different results.

Reducing Power Sector CO_2 Emissions

- When a cap on power sector CO_2 emissions is assumed, it is projected to have significant impacts on all aspects of the electricity production business. The key CO_2 compliance strategy is expected to be retirement of coal-fired capacity in favor of natural gas and, to a lesser extent, renewables, as well as the continued operation of more existing nuclear power plants.[3] Consumers are also expected to reduce their use of electricity in response to higher electricity prices.
- The electricity price impacts of meeting a CO_2 cap are much larger than those of meeting NO_x, SO_2, or Hg caps. When a cap on power sector CO_2 emissions at 7 percent below the 1990 level is assumed, average retail electricity prices are projected to be 43 percent above reference case levels in 2010.

Establishing a 20-Percent RPS

- A requirement that 10 percent of all power sales must come from nonhydroelectric renewable fuels by 2010 and 20 percent by 2020 is projected to cause power suppliers to slow the expected increase in their use of natural gas and, to a lesser extent, coal.
- Biomass, wind, and geothermal resources are projected to provide most of the required increase in renewable generation.
- The imposition of the RPS is projected to lead to slight reductions in power sector NO_x, SO_2, and Hg emissions and a larger reduction in CO_2 emissions. CO_2 emissions in 2020 are projected to be 18 percent lower when a 20-percent RPS is assumed than in the reference case forecast—still 35 percent above the 1990 level.
- The renewable credit price, or subsidy for nonhydroelectric renewables, is projected be between 4 and 5 cents per kilowatthour. The development of renewable generating facilities to comply with a 20-percent RPS is projected to lead to a 4-percent increase in electricity prices by 2020 relative to the reference case, because of the need to deploy higher cost renewable resources to meet the target.
- Lower use of natural gas in the electricity sector when a 20-percent RPS is assumed is projected to cause average wellhead prices for natural gas to be 7 percent lower in 2010 and 17 percent lower in 2020 than projected in the reference case.

Reducing Power Sector NO_x, SO_2, CO_2, and Hg Emissions

- The projected impacts of a power sector cap on CO_2 emissions dominate those of caps on other emissions. The key compliance strategy is a shift from coal to natural gas and, to a lesser extent, renewables, requiring costly capital additions. Consumers are also expected to reduce their use of electricity in response to higher electricity prices.
- Higher natural gas prices and CO_2 allowance prices for electricity producers are projected to result in higher electricity prices for consumers—37 percent higher than projected in the reference case in 2010—when NO_x, SO_2, and Hg emissions caps are imposed together with a CO_2 emissions cap set to 7 percent below the 1990 level.
- When the reference case technology assumptions for natural gas discovery and production are replaced with assumptions of less robust technology development, the projected price of electricity in 2020 with combined NO_x, SO_2, Hg, and CO_2 emission caps is 8 percent above the projection based on reference case natural gas technology assumptions.
- The price impacts of the emission caps are sensitive to assumptions about how electricity will be priced in the future and the policy instrument used to reduce emissions. If suppliers do not pass on the opportunity costs of CO_2 allowances in regulated regions, the price impacts of imposing the emission caps could be smaller—25 percent higher than the reference case level in 2010 rather than 37 percent higher; however, because consumers would have less incentive to conserve and power suppliers would need to develop renewable fuel facilities to meet the higher level of demand, the compliance costs for power suppliers are projected to be higher. Similarly, an earlier analysis showed that if emissions allowances were allocated using a dynamic generation performance standard, the price impacts would be lower but the impacts on resource costs would be higher.[4]

[3]At the request of the Subcommittee, it was assumed that no new nuclear units would be constructed.

[4]See J.A. Beamon, T. Leckey, and L. Martin, "Power Plant Emission Reductions Using a Generation Performance Standard," web site www.eia.doe.gov/oiaf/servicerpt/gps/gpsstudy.html.

Reducing Power Sector NO_x, SO_2, CO_2, and Hg Emissions With an RPS

- Combining a 20-percent RPS requirement in 2020 with caps on NO_x, SO_2, Hg, and CO_2 emissions is projected to reduce the shift to natural gas as a fuel for electricity generation and increase the use of renewable fuels. The renewable credit price, or subsidy for nonhydroelectric renewables, is projected to be approximately 3 cents per kilowatthour.
- The switch to renewables instead of natural gas is expected to lead to lower natural gas prices than would otherwise be expected. For example, when power sector caps on NO_x, SO_2, Hg, and CO_2 emissions (at 7 percent below the 1990 level) are combined, the projected wellhead price of natural gas in 2020 is 16 percent higher than projected in the reference case; but when a 20-percent RPS by 2020 is also assumed, the projected wellhead natural gas price in 2020 is only 3 percent higher than in the reference case. The lower natural gas price would benefit both electricity consumers and natural gas users in other sectors of the economy.
- The addition of the RPS to caps on NO_x, SO_2, CO_2, and Hg emissions is projected to increase the resource costs of compliance faced by power suppliers by $21 billion over the 2000 to 2020 time period from what it would be without the RPS requirement. In 2010, electricity prices are projected to be 40 percent above the reference case level when a 20-percent RPS is combined with caps on NO_x, SO_2, Hg, and CO_2 (at 7 percent below the 1990 level), as compared with 37 percent when the RPS is not included. However, because the RPS leads to lower natural gas prices and, in turn, lower CO_2 allowance prices, electricity prices are projected to be lower in 2020 when the RPS is included than when it is not.

Uncertainties

- The changes required to comply with the power sector emission caps analyzed in this report, especially the caps on CO_2 emissions, are projected to cause significant shifts in the generating capacity and fuels used to produce electricity. There is substantial uncertainty about how the various fuel markets—for coal, natural gas, and renewables—might respond to the projected changes, as well as the degree to which consumers might respond to the projected increases in electricity prices. History does not offer clear guidance as to how the various markets might respond to changes as large as those required by the proposed emissions targets.
- As with any 20-year projection, the role that new technologies might play is uncertain. Although this analysis incorporates assumed improvements in technology costs and performance over time, the true evolution of new technological development is unpredictable. Costs and performance could be lower or higher than those assumed in this analysis, particularly for technologies that reduce Hg and for renewable energy technologies.